Team Deliberate Practice in Medicine and Related Domains: A Consideration of the Issues

Kevin R. Harris, PhD[1], David W. Eccles, PhD[2], John H. Shatzer, PhD[3]

1. Department of Psychology, Austin Peay State University, Clarksville, TN, 37044, USA
2. School of Applied Social Sciences, Durham University, Durham, DH1 3HN, UK
3. Vanderbilt University School of Medicine*, Nashville, TN, 37232, USA (*retired)

Running head: Team Deliberate Practice

Corresponding author

Kevin R. Harris, PhD

Department of Psychology

Austin Peay State University

P.O. Box 4537

Clarksville, TN 37044-4594

USA

Tel: 931-221-6505

Fax: 931-221-6267

Email: harrisk@apsu.edu

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Abstract

A better understanding of the factors influencing medical team performance and accounting for expert medical team performance should benefit medical practice. Therefore, the aim here is to highlight key issues with using deliberate practice to improve medical team performance, especially given the success of deliberate practice for developing individual expert performance in medicine and other domains. Highlighting these issues will inform the development of training for medical teams. The authors first describe team coordination and its critical role in medical teams. Presented next are the cognitive mechanisms that allow expert performers to accurately interpret the current situation via the creation of an accurate mental "model" of the current situation, known as a situation model. Following this, the authors propose that effective *team* performance depends at least in part on team members having similar models of the situation, known as a shared situation model. The authors then propose guiding principles for implementing team deliberate practice in medicine and describe how team deliberate practice can be used in an attempt to reduce barriers inherent in medical teams to the development of shared situation models. The paper concludes with considerations of limitations, and future research directions, concerning the implementation of team deliberate practice within medicine.

Key words: deliberate practice; medical education; simulation; situation model; team deliberate practice; team performance

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Ericsson (2004) proposed the concept of deliberate practice as a means to acquire and maintain expert performance in medical domains. Deliberate practice includes: (a) repetitive performance of skills in a focused domain, along with (b) rigorous skills assessment, that provides learners with (c) informative feedback, which results in (d) enhanced skills performance, in a controlled setting (Issenberg et al., 2005). Evidence suggests incorporating deliberate practice principles within medical training improves performance in simulated and real clinical settings (Masiello, 2011; Tsuda et al., 2009), and is more effective than traditional clinical training methods for achieving training goals (McGaghie et al, 2011). However, deliberate practice is typically designed for individual performance, whereas healthcare tasks are often undertaken by teams. Moreover, poor teamwork (Kohn et al., 2000) is a key cause of preventable errors in healthcare, leading to calls for improving team training in healthcare (Undre et al., 2007). In turn, there have been calls to consider the applicability of deliberate practice principles to training medical teams (Masiello, 2011). To help answer these calls, we highlight here key issues with using deliberate practice to improve team performance, which we label *team deliberate practice*. We begin by outlining the critical role of team coordination in performance in teams and proposing that effective team coordination partly depends on team members having a shared (i.e., similar) understanding of the situation encountered, which is known as a *shared situation model*. We then present "guiding principles" for implementing team deliberate practice in medicine and propose how such practice may reduce barriers in medical teams to the development of shared situation models. We end with considerations of limitations and challenges, and future research directions, concerning the implementation of team deliberate practice in medicine.

Team coordination in medical teams

Medical teams typically comprise multiple individuals from different specializations and backgrounds. Because different team members are usually responsible for different team activities, teams must coordinate their members' activities, which involves arranging members' actions so that the correct actions are performed at the correct times and locations so that these actions are in suitable relation to achieve the best result (Eccles, 2010). Thus, coordination is required because medical team members are interdependent: The performance of each member partly depends on the performance of each of the remaining members) such that members cannot select actions at their own discretion (Eccles, 2010). Research indicates that performance in medical teams depends partly on the team's ability to coordinate its members' actions. For example, high-performing medical teams have been shown to adapt the coordination of their activities in response to non-routine events (Burthscher et al, 2010). Conversely, deaths and major complications are much more likely when teamwork behaviors are exhibited infrequently by medical teams (Mazzaco et al., 2009)... Such findings highlight the importance of research on factors that enhance patient outcomes by affecting coordination in medical teams. Having described team coordination and its role in medical team performance, we now propose that effective team coordination partly depends on team members having a shared understanding of the medical situation encountered, which is known as a shared situation model.

Deliberate practice by an individual in a domain leads to two key cognitive adaptations (Ericsson & Kintsch, 1995): increasingly extensive domain-related knowledge, and changes to memory that allow domain-related information to be mentally processed more quickly and reliably during performance. These adaptations in turn allow the individual to obtain an accurate interpretation (i.e.., one reflecting reality) or "mental model" of an encountered situation. This

model is known as a "situation model"[1]. These adaptations also allow the individual to update their situation model as the situation changes, which is critical in dynamic domains such as medicine (e.g., patient states can change rapidly). Being able to create an accurate situation model and update it enables the perfomer to: (a) select responses appropriate to the situation; and (b) accurately anticipate changes to the situation, which affords preparation of responses in advance of these changes. Anticipating the different possible consequences of a fever, for example, would allow a physician to increase patient monitoring, prepare treatment resources, and so on.

In a team setting, it is possible for individual team members to create different models of a situation because each member has a different knowledge base. For example, two members might notice the same patient symptoms but interpret them differently due to differences in their knowledge, leading these members to create different models of the same situation (Katz, 2007). This outcome is inconsequential when individuals are working independently but medical teams work interdependently, requiring that they coordinate their members' actions, and thus team members must have similar models of the situation. The term "shared situation model" has been proposed to describe a state in which all members of a team have (i.e., share) the same situation model (Eccles and Groth, 2007; Fiore and Salas, 2004). When a team achieves a shared situation model *and* that model reflects the situation accurately, all team members can draw on that same model to effectively resolve the situation. More specifically, shared mental model allows each team member to obtain a similar understanding about: what situation is being addressed; the current status of the situation; and how the team is going to respond to the situation and coordinate their actions to deliver that response.

So far, we have highlighted the advantages of establishing a shared mental model but there are also disadvantages to this outcome. Social dynamics inherent within teams can lead teams to form inaccurate shared mental models; that is, shared mental models that do not reflect the situation encountered. Mannion and Thompson (2014) reviewed the possible biases affecting medical group decision-making. They highlighted how groupthink can occur within teams, which describes how team cohesiveness creates biases in decision-making, such when the voicing of task-relevant information by team members is suppressed because it challenges established team norms underpinning cohesion. Thus, training must emphasize active participation from all team members so that teams can establish not just shared, but also accurate situational models (Mannion & Thompson, 2014); later, we present suggestions to this end.

Teams typically establish an accurate, shared situational model via two pathways (Eccles and Tenenbaum, 2004; Fiore and Salas, 2004); see Figure 1. In "pathway A," each member (a) attends to similar environmental information concerning the situation encountered, the current status of the situation, and how the team is going to respond to the situation; *and* (b) interprets this situation-related information similarly on the basis of similar knowledge. This mode of coordination is labelled implicit coordination because the team creates and updates its shared situation model *without* explicit communication between team members. By contrast, in "pathway B," team members establish a shared situational model by explicitly and intentionally communicating about the situation currently being addressed, the current status of the situation, and how the team is going to respond to the situation.[2]

Insert Figure 1 about here

Because deliberate practice has not been proposed previously as a means of training medical teams, we now present guiding principles for implementing team deliberate practice, which offer broad guidance for applying and researching this approach.

Guiding principles and framework for implementing team deliberate practice in medicine.

These guiding principles are derived from Ericsson and colleagues' (e.g., Ericsson et al., 1993) work on individual deliberate practice. The first guiding principle is that prolonged engagement in increasingly difficult deliberate practice activities is central to team deliberate practice. Deliberate practice involves repeatedly practicing a target task in a controlled setting. One concern about the transfer of this approach into medical team training is that strict repetition of the kinds of task undertaken by medical teams might not be possible (and, even if possible, might not be useful) because such tasks are rarely exactly the same; medical teams are characterized by pronounced variability in team structure, clinical context, and so on. However, it is a class of task that should be practiced repeatedly, not the specific parameters of that class of task; in contrast, the task parameters should be different (i.e., not repeated) across practices because the learner must experience during practice the variability in task parameters they will encounter in the real world. For example, "challenging a senior colleague" (described below) is a class of task. Training this class of task would involve engagement, within a controlled environment, in a set of practice scenarios (i.e., repeated practice). Each scenario would require challenging a senior colleague but each would also differ in terms of specific task parameters (e.g., different senior colleagues, clinical contexts, etc.) in ways representative of the real world.

A second guiding principle is that the deliberately practiced activities are evidence-based; that is, research must have shown that the selected activities enhance performance. Identifying skilled performers via objective measures of performance, such as tissue damaged in surgery,

and then identifying the training responsible for the development of this level of performance, has been useful for identifying effective training for individuals (Harris et al., 2013). Thus, researchers should first identify the highest performing teams (see the next principle), then the mechanisms allowing for this superior performance, and finally how the team arrived at this level of performance.

A third guiding principle is that deliberate practice involves clear, objective, and quantifiable measures of performance and improvements in it. Existing measures of team performance are typified by ratings of perceptions of training and questions about one's own coordination or cooperation (Paige et al., 2009). Such self-report measures are limited in important ways. For example, in the absence of feedback about one's performance, experience of cardiac arrest resuscitation attempts increases confidence about performing resuscitations but not *skill* at performing resuscitations (Marteau et al., 1990). Similarly, team-based training may lead to perceptions that team performance is being enhanced, even when no actual improvements result. Therefore, researchers should prioritize identification of objective performance measures.

More generally, team deliberate practice may offer a guiding structure for implementing any form of team training. Because exact training modes are not prescribed by team deliberate practice, many existing approaches to training (e.g., training techniques, equipment, curricula) may be useful within the structure of team deliberate practice (e.g., Harris, Eccles et al., 2013). To summarize, team deliberate practice is not presented here as a replacement to all other forms of training, but rather as a framework to ensure objective measures of team performance and assessment, as well as a means to identify new or more effective training content when needed. Having proposed guiding principles for implementing team deliberate practice in medicine, we

now describe key barriers within medical teams to the development of a shared situation model and ways to reduce these barriers via team deliberate practice.

Reducing cognitive barriers to shared situation models in medical teams via team deliberate practice.

Cognitive barriers to shared situation models include differences in team member skill-level, signal-detection errors, ambiguity, task interruptions, and perceived competence. These barriers, and possible ways to reduce them via team deliberate practice, are discussed below.

Differences in skill-level, signal-detection errors, and ambiguity. One cognitive barrier to establishing shared situation models includes differences between team members in skill level. When a team member has difficultly creating an accurate situation model because they are inexperienced, other team members' situation models must be accurate enough to allow them to aid the inexperienced individual's performance. This aid might take the form of explicitly communicated instructions (i.e., pathway B in our model) about what is required of the inexperienced member. Team members may also erroneously conclude that all team members are interpreting the situation similarly, which is known as a *perceived sharedness error* (Eccles, 2010). Such errors can affect team performance because team members believe (erroneously) they have achieved a shared situation model and thus often stop explicitly checking that this is actually the case, increasing the chances of subsequent coordination breakdowns.

Signal detection errors are also potential barriers to establishing shared situation models. These errors concern pathway A in our model because they involve failures to detect signals (e.g., shallow breathing or cancerous cells) in the situation. Within signal detection theory (Green and Swets, 1966), signals are present or absent in the environment and a judgment is made by a performer about whether these signals are present or absent. Signal detection can be

critical in dynamic situations (e.g., in emergency care) in which multiple individuals are responsible for making judgments and the coordination of the team is tied to those judgments. The judgment of a single caregiver will influence the judgment of other caregivers, which will influence still others.

Ambiguity is also a barrier to establishing a shared mental model. Ambiguity about one's role in healthcare teams is a common feature of malpractice lawsuits, especially during patient handovers and when caregivers differed in rank (Greenberg et al., 2007). Such cases likely involve perceived sharedness errors (described above) because, within the cases, team member roles were not allocated explicitly (i.e., via pathway B in our model). Thus, one caregiver could (erroneously) assume that another caregiver would provide the appropriate care.

The cognitive barriers to shared situation models described above might be reduced via team deliberate practice involving inter-professional medical teams. Training should involve highlighting to all team members key information about the current situation and the team's intended response to it, so that this information is shared effectively within the team. To this end, training has involved task checklists, de/briefings, and "time-outs" (Awad et al., 2005; Makary et al., 2006; Stahl et al., 2009). These "information highlighting" approaches should reduce perceived sharedness errors within teams (described above) and but have yet to receive empirical testing. Additionally, deliberate practice by teams at identifying ill-timed, incomplete, or incorrect information sharing will increase members' sensitivity to these types of errors. Researchers have suggested using "triggers" (e.g., the introduction of a crisis situation) within simulations that require teams to engage in teamwork to prevent patient harm (Shapiro et al., 2008), allowing trainers to assess this teamwork. Because such triggers allow performance

observation and measurement, trainers can continuously update training as the mechanisms underpinning successful performance are identified.

Task interruptions. Task interruptions are salient within healthcare because they impact task completion time and accuracy (Cades et al., 2011). Interruptions during team performance have various causes including the sudden need to attend to another patient (Chisholm et al., 2001). A team member's ability to resume a task post-interruption can be aided or hindered by other team members. Consider a physician required to switch attention from one patient to another. When the physician switches her attention back to the first patient, a nurse with an accurate (vs. less accurate) situation model concerning this first patient might, via explicit communication with the physician (i.e., via pathway B in our model), allow the physician to resume care relatively easily. The effects of task interruptions on shared situation models can be attenuated via team deliberate practice. Cades et al. (2011) provided suggestions for training novices to recover from interruptions that included using pairs of tasks: a primary task (e.g., triaging patients) and common interruptions (e.g., equipment alarms).

Perceived competence/manageability. All medical professionals experience occasional stressful feelings about their competency. In individuals, stress affects various cognitive processes including divided attention (LeBlanc, 2009), which is involved, for example, when reading values on medical equipment while listening to a nurse provide a report. Stress is moderated by the perceived manageability of the situation (Harvey et al., 2010). Thus, a team member who experiences high stress after assessing a medical situation as "hopeless" will create a situation model quite different from that created by a team member who interprets this situation as "manageable". A performer with a "hopeless" situation model is more likely to miss information important to the situation; that is, pathway A in our model would be affected. Thus,

training should be focused on changing performers' appraisals of simulated, and later real-world, prototypical situations. Team deliberate practice activities could involve pairing individuals who consistently judge situations as manageable with individuals who do not.

Reducing social barriers to shared situation models in medical teams via team deliberate practice.

Social barriers to establishing shared situation models include social resistance, "captainitis," differences among subspecialties, and lack of leadership. These barriers, and possible ways to reduce them via team deliberate practice, are discussed below.

Social resistance, "Captainitis", and differences among subspecialties. Social resistance is a potential barrier to establishing shared situation models. That most team members may contribute to medical decision-making is a recent idea. Reviews have revealed cases of medical staff engaging in disruptive behaviors such as entering inappropriate information into medical records (Katz, 2007) and purposely excluding team members from team communications (Paige, 2010). Disruptive behaviors can affect the establishment of a shared situation model in a team by affecting pathways A and B in our model. These behaviors may reflect personality flaws of individual physicians but may also represent statements by physicians that they are ultimately "in charge." Clearly, some healthcare team members resist the establishment of shared situation models for reasons of power, with potentially adverse consequences for team coordination.

"Captainitis" is also a barrier to establishing shared situation models that affects pathway B in our model. Captainitis is an aviation term and is defined as leaders deliberately overlooking information provided by subordinates or subordinates lacking the confidence to provide information to leaders (Foushee, 1984). Accounts of disruptive behaviors along with reports that conflict between team members occurs in 50-78% of patient cases (Katz, 2007) highlight the

importance of considering the impact of "captainitis" on the establishment of shared situation models in medical teams. Training designed to improve information detection (discussed above) will be ineffective if this information is not considered or shared due to captainitis. The establishment of shared situation models depends on effective intra-team communication and thus training must address "captainitis" by emphasizing open communication and respect for all team members' input.

Another barrier to establishing shared situation models is differences among subspecialties. As novices develop professional identities, evidence suggests they adopt the boundaries and biases of those already established in the profession (Lingard et al., 2002), which can create "silo mentalities" (Paige, 2010). Professional indoctrination leads to differences in how individuals from different specialties interpret the intentions of a given team member (Lingard et al., 2002), which affects the establishment of a shared situation model via pathway B in our model. The silo mentality also affects perceptions of teamwork and appropriate rules for behavior within teams (McDonald et al., 2005; Makary et al., 2006; Undre et al., 2006). For example, Thomas et al. (2003) found that physicians rated the quality of nurse-to-physician collaboration as high but, in contrast, nurses provided poor ratings of such collaboration.

The social barriers to shared situation models created by social resistance, "captainitis," and differences among subspecialties within the team might be reduced by involving inter-professional medical teams in team deliberate practice. Katz (2007) proposed that attempts to remove these social barriers in medical teams will likely lead to conflict because professional norms are entrenched and offered strategies for resolving such conflict. For example, practice should involve simulations that generate conflict (e.g., limited resources) to provide teams with opportunities to experience and attempt to resolve such conflict. Boot camps (Cohen et al., 2013)

could be used to strengthen inter-professional relations by including "inter-professional components" involving different professions working together during simulated cases. Finally, assertiveness training may reduce the effects of "captainitis" (Thomas et al., 2003). As such, there is value in simulated practice scenarios wherein trainees are encouraged to contribute to the team's decision-making despite most team members being of senior rank or from other subspecialties.

Lack of leadership. We proposed above that open communication (i.e., pathway B in our model) across different ranks in medical teams facilitates the establishment of a shared situation model. Therefore, it might seem inappropriate to consider lack of leadership as a barrier to establishing such a model. Nonetheless, research indicates that the emergence of a leader within a medical team results in better team performance (Carlson et al., 2009; Ten Eyck et al.,2010). Team leadership may facilitate team performance because leaders oversee the intra-team communication (i.e., pathway B in our model) required for effective team coordination. However, most residents feel ill-prepared to lead teams (Hayes et al., 2007) and thus team deliberate practice should involve leadership training, including via simulation-based practice (Carlson et al., 2009).

Potential limitations and challenges associated with implementing team deliberate practice in medicine

The available evidence of the utility of deliberate practice for training individuals within medicine is largely encouraging (McGaghie et al, 2011; Masiello, 2011; Tsuda et al., 2009). Nonetheless, medical researchers and educators must consider carefully the potential limitations of team deliberate practice and challenges to implementing this approach. We consider these

issues here, and in relation to each issue, propose how future research might help resolve these issues and in turn provide clearer guidance for researchers and educators.

Recently, the deliberate practice approach has been criticized on the basis that the power of deliberate practice for explaining improvements in performance has been "over-sold". Researchers have proposed that, while deliberate practice may well be necessary to explain improvements in performance, it is not sufficient in this regard, and that the effect of other individual differences (e.g., in an individual's working memory capacity) on learning must be considered also (Campitelli & Gobet, 2011; Kulasegaram et al., 2013; Hambrick et al., 2014). Certainly, caution is warranted until research has been conducted on the effectiveness of team deliberate practice.

A second concern with team deliberate practice, as proposed here, is that it emphasises training involving complete medical teams, which may be challenging to implement due to medics' conflicting clinical priorities (Nestel et al., 2008). One possible solution would be to create simulated teams by training "standardized participants" to depict specific roles on those teams (Kassab et al., 2010). However, this approach also has its challenges. In a study by Kassab et al. (2010), real surgeons reported that actors playing assistants on surgical teams lacked familiarity with equipment and procedures. Actors lacking a true understanding of the situation, may be unable to provide appropriate information to contribute to the team's shared situation model, resulting in an inaccurate shared situation model. Nonetheless, simulation realism is likely to increase as actors are trained for, and can gain experience within, their roles. Alternatively, simulation centers could use healthcare staff interested in additional employment within simulations or require personnel to allocate some time for "simulation duties".

Another caveat concerning team deliberate practice is that the composition of medical teams changes often, so any effects of such practice must be generalizable, such that team members can establish shared situation models in teams containing unfamiliar members. Promisingly, research on military teams indicates that changes in team membership can actually benefit performance because team members who do not know each other (vs. do know each other) communicate more explicitly, which helps establish a shared situation model (Gorman and Cooke, 2011). Researchers should establish if this is true for medical teams.

Finally, team deliberate practice might be expensive to implement. In some cases, the infrastructure (e.g., simulation centers) required to implement team deliberate practice may be in place already, which would reduce the costs associated with this approach. Also, it might be possible that current training techniques can remain in place and an objectively-based curriculum developed if needed. Another possible way of minimizing costs would be to build on existing infrastructure incrementally such that team deliberate practice can be empirically tested on a small-scale. Lastly, creating online training that allows learners to undertake team deliberate practice with virtual teammates would reduce training costs over the long-term (Lee, 2006).

Conclusion

The principles of deliberate practice have been applied successfully in medical education, leading to calls for these principles to be applied to training medical teams. We have presented considerations for applying these principles to training medical teams and posed questions to help researchers and educators understand the opportunities and limitations afforded by team deliberate practice. It is only with appropriately, and consistently, administered and tested team deliberate practice that we will better understand the effectiveness of applying deliberate practice principles to medical teams.

Endnotes

1. A suggested considering how the concept of situation awareness might augment our proposed model (e.g., see Crozier, Ting, Boone, O'Regan, Bandrauk, Furey,. . . Hogan (2015). While the situation awareness and situational model concepts have arisen within different literatures, their nature is quite comparable and so it is inappropriate to consider both concepts within the model proposed.
2. A reviewer remarked that pathway "a" may rely too much on luck in healthcare training and pathway "b" should be prioritized during training; that is, that healthcare learners should be as explicit as possible whenever there is doubt concerning the situation model. We agree with this point but also recognize the value of training pathway "a" because, even if training pathway "b" is prioritized, the use of pathway "a" to establishing a shared situation model by teams is inevitable during performance.

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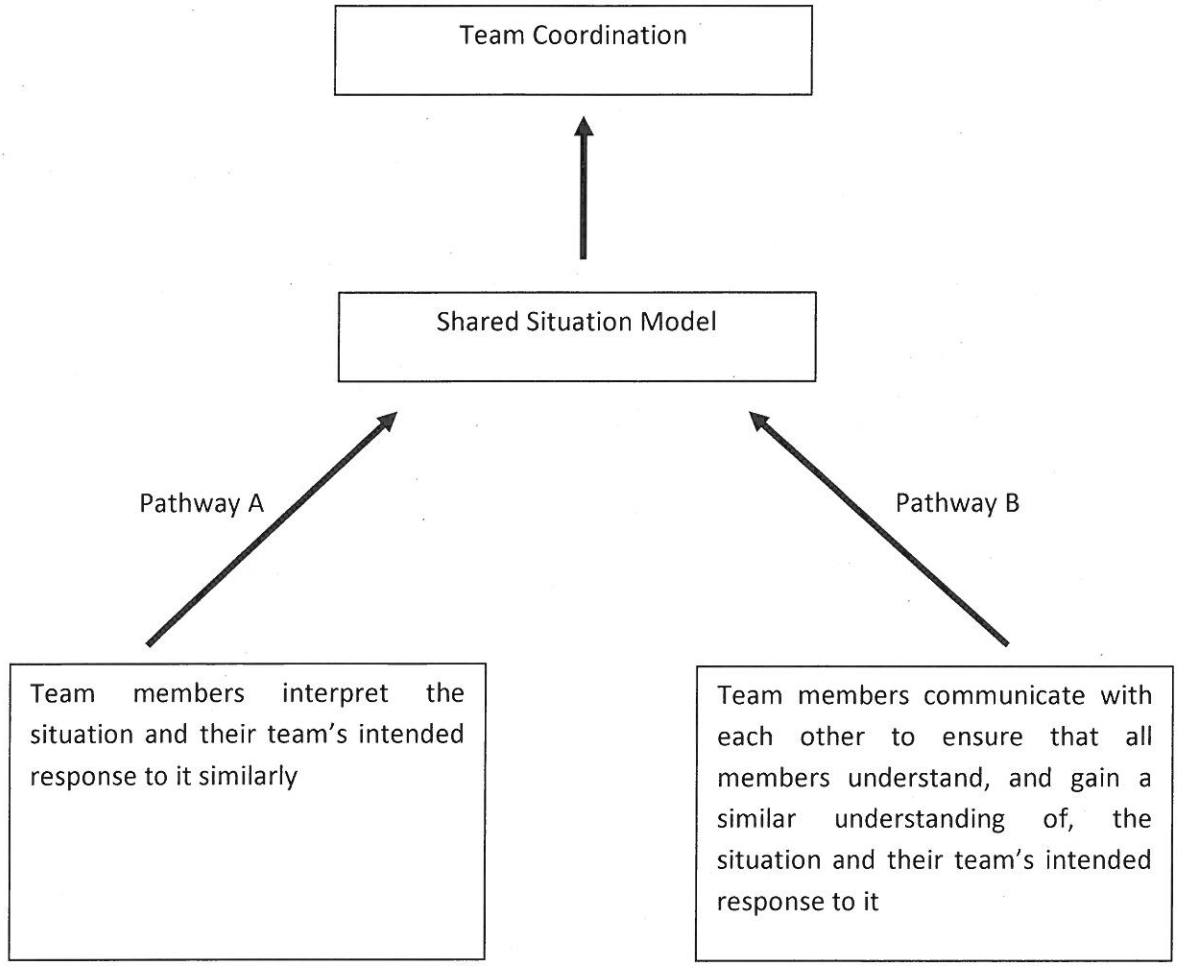
Team Coordination
Shared Situation Model
Pathway A
Pathway B
Team members interpret the situation and their team's intended response to it similarly
Team members communicate with each other to ensure that all members understand, and gain a similar understanding of, the situation and their team's intended response to it